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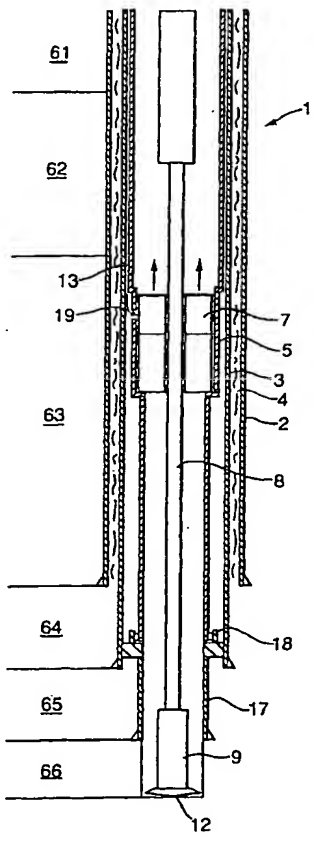

(57) Abstract: The invention relates to a drilling assembly for drilling a borehole into geological formations which assembly comprises: a drilling shaft placable in the borehole, which shaft comprises a drilling head and a pump device placable in the borehole, wherein the pump device comprises sealing means for sealing a first borehole part below the sealing means from a second borehole part above the sealing means, and wherein the pump device is enabled to pump a fluid from the first borehole part to the second borehole part.

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ASSEMBLY FOR DRILLING LOW PRESSURE FORMATION

The invention relates to a drilling assembly for drilling a borehole into geological formations, comprising a drilling shaft placable in the borehole, which shaft comprises a drilling head.

Holes are drilled onshore and off-shore for getting access to oil fields and gas fields. These fields are located underground in one of the geological layers.

When drilling a borehole a drilling fluid is used to transport cuttings out of the borehole. With borehole depths of some hundreds of meters up to some kilometres the hydrostatic pressure at the bottom of the borehole could be some hundreds of bars.

Because of these high hydrostatic pressures, the drilling fluid has the tendency to penetrate the geological formations. When entering the formation layer, in which the energy source, such as oil or gas, is located, the drilling fluid could penetrate this layer through which this layer gets clogged and the production of gas or oil is affected. This problem arises especially with low pressure fields.

It is known to adjust the density of the drilling fluid in order to adjust the hydrostatic pressure at the bottom of the borehole. However this hydrostatic pressure variation generally does not correspond to the pressure variation in the specific formation layer. Especially when drilling a borehole in a low pressure field, the maximum pressure of this field could be substantially lower than the hydrostatic pressure of the drilling fluid.

It is an object of the invention to provide a drilling assembly which enables a better control over the

hydrostatic pressure of the drilling fluid in the zone of the formation in which the energy source is present.

This object is achieved by a drilling assembly for drilling a borehole into geological formations, which assembly comprises:

- a drilling shaft placable in the borehole, which shaft comprises a drilling head; and
- a pump device placable in the borehole, wherein the pump device comprises sealing means for sealing a first borehole part below the sealing means from a second borehole part above the sealing means, and wherein the pump device is enabled to pump a fluid from the first borehole part to the second borehole part.

The pump device eliminates the hydrostatic pressure caused by the fluid column above the pump device. So the only hydrostatic pressure present at the bottom of the drilled borehole is caused by the fluid column between the bottom of the borehole and the pump device. This enables one to vary the pressure at the bottom of the borehole between the hydrostatic pressure caused by the fluid column between the bottom and the pump device and the hydrostatic pressure of the total fluid column in the borehole.

Preferably the drilling assembly further comprising a substantially tube shaped casing placable in the borehole, and wherein the sealing means includes a first sealing for sealing the pump device on the casing inner wall and a second sealing for sealing the pump device on the drilling shaft, such that in longitudinal direction the first borehole part is sealed off from the second borehole part.

In a preferred embodiment the drilling assembly according to the invention comprises near one end of the casing a valve for closing said one end of the casing.

The valve is helpful for closing off the bottom part of the borehole when the pump device is removed from the

borehole in order to install for example a casing into the newly drilled part of the borehole. In a preferred embodiment of the invention, the pump device is rotatably arranged on the drilling shaft. The drilling shaft provides in this way a guide for the pump device and makes it easy to seal the pump device on the drilling shaft, when the drilling shaft is rotated in order to deepen borehole. Preferably the drilling shaft comprises a slick drilling string. This has the advantage that with this assembly a borehole can be deepened over a substantial length. Conventional drilling strings comprise thickenings, which limit the stroke, which the drilling string of the assembly according to the invention can make through the pump device.

In another preferred embodiment the pump device is drivable by a driving fluid. This is preferably the drilling fluid. As the borehole is already filled with drilling fluid, this can be used to drive the pump device. Only a supply channel has to be arranged to supply the fluid to the pump and the discharge pipe is formed by the already drilled borehole. It is also possible to drive the pump with an electric motor.

In another embodiment of the drilling assembly according to the invention an opening is arranged in the casing wall to which the pump device is connectable. In this embodiment the supply channel for the driving fluid is formed by the space between the casing and the surface of the borehole. The driving fluids can be pumped through this space and through the opening in order to drive the pump device.

In yet another embodiment the pump is reversible in order to pump the fluid above the first sealing away, preferably via the annulus formed by the casing of the assembly and the already drilled borehole.

The invention also relates to a method for drilling a borehole into geological formations, which method comprises the steps of:

- arranging a drilling shaft in the borehole, which shaft comprises a drilling head;
- arranging a pump device in the borehole, wherein the pump device comprises sealing means for sealing a first borehole part below the sealing means from a second borehole part above the sealing means;
- operating the pump device so as to pump a fluid from the first borehole part to the second borehole part; and
- driving the drill shaft to deepen the borehole.

The sealing is done such, that the drill string can still extend pass this sealing means. The sealing means is used to separate the bottom part of the borehole from the upper part of the borehole. This in order to enable the pump to create a pressure difference between the two parts.

To remove the drilling shaft from the borehole, suitably the following steps are included:

- lifting the drilling shaft to a position in which the drill head is located underneath and adjacent the sealing means;
- pumping away at least a part of the fluid present above the sealing means;
- opening the sealing means; and
- removing the drilling shaft from the borehole.

Preferably said sealing means is a primary sealing means, and the method of removal of the drilling shaft further comprises:

- arranging a secondary sealing means in the borehole below the drilling head.

To remove or replace the drill string suitably the method further comprises:

- lowering the drilling shaft into the borehole to a position in which the drill head is located between the primary and secondary sealing means;
- closing the primary sealing means;
- pumping fluid from underneath the primary sealing means to above the primary sealing means; and
- opening the secondary sealing means.

According to the invention a secondary sealing means is provided which divides the bottom part of the borehole in two sections. This secondary sealing means can be embodied as a valve. It creates a lock chamber through which the drilling head can be removed from the lower borehole part and be transferred to the upper borehole part, while keeping the low hydrostatic pressure at the bottom of the borehole.

When the pump device is again in place in the casing, the lock chamber can be depressurized by pumping the fluid to the upper part of the borehole. This makes it possible to open the second sealing and to bring the drilling head to the bottom of the borehole to deepen the borehole further. This method can also be used to transport a casing through the bottom part of the borehole, after which installation it is not necessary to maintain the low pressure at the bottom of the borehole, as the casing prevents penetration into the formation layer.

These and other features and advantages of the present invention are described in more detail in the following in combination with the drawings.

Figures 1-5 show five different steps of drilling a borehole into geological formations with a first embodiment of a drilling assembly according to the invention.

Figures 6 and 7 show two steps of removing a second embodiment of a drilling assembly according to the invention.

In figure 1 a tube shaped casing 5 of a first embodiment of a drilling assembly 1 according to the invention is placed into an already drilled borehole, which is lined by three casings 2, 3, 17. The space between the two casings 2, 3 is filled with concrete 4.

The three casings 2, 3, 17 penetrate a number of geological formations G1-G5. In order to deepen the borehole into the geological formation G6, which contains the energy source, such as gas or oil, the drilling assembly 1 is used.

After the casing 5 is landed into the so-called Polish Bore Receptacle 18, a slick drill string 8 on to which a pump device 7 is brought into the casing 5 (see figure 2). The inner wall of the casing 5 is stepped to provide a shoulder 6 on which a pump device 7 is supported.

A slick drill string 8 extends through this pump device 7. At the bottom end of this slick drill string 8 a drilling head 9 is arranged (see figure 3).

The pump device 7 is sealed on the casing 5 by a first sealing 10 and the pump device 7 is sealed on the slick drilling string 8 by a second sealing 11.

For deepening the borehole, the drill string 8 with the drilling head 9 is lowered to the bottom 12 of the borehole (see figure 4).

When deepening the borehole a part of this newly drilled part does not yet have a casing. In order to prevent drilling fluid penetrating the geological formation G6, the pump device 7 reduces the hydrostatic pressure of the drilling fluid column present in the drilling borehole. The hydrostatic pressure can be limited by the pump device 7 to a pressure equal to the drilling fluid column extending from the bottom 12 to the pump device 7. So the pressure caused by the drilling fluid column above the pump device 7 is eliminated. The pump device 7 could be an electric pump or could be

driven by a driving fluid 19, which is pumped through a channel 13 which is present in the annulus formed between the casing 5 of the drilling assembly 1 and the already installed casing 2.

Now referring to figure 5, when the drill string 8 has to be removed from the borehole, the pumping action of the pump 7 is reversed, such that drilling fluid 20 present above the pump is pumped away via the annulus 13 out of the borehole. When enough drilling fluid has been pumped away, i.e. the hydrostatic pressure of the full drilling fluid column substantially equals the pressure present in the formation G6, the pump 7 and drill string 8 can be removed from the borehole.

Referring to figure 6, a second embodiment of a drilling assembly according to the invention further comprises a valve 14. The remaining construction of the assembly is similar to the assembly according to figure 1-5. Similar components are designated with the same reference signs as in figures 1-5.

This valve 14, which is arranged in the casing 5 of the drilling assembly, is used to shut off the bottom part 15 of the drilled borehole. In some circumstances it is because of safety regulations necessary that the borehole is fully filled with drilling fluid, for example in case the geological layer G6 contains very poisonous gasses, such as H_2S.

When removing the pump device 7, this valve 14 prevents that the hydrostatic pressure in the bottom part of the borehole 15 increases to a pressure equal to a fluid column with the height of the full borehole.

With this valve 14 shut, the drill string 8 together with the pump device 7 can be removed from the borehole for example in order to exchange the drilling head 9 (see also figure 7).

When reintroducing a new drilling head or for example a liner for the newly drilled part of the

borehole, the pump device 7 is again supported by the shoulders 6. The pump device 7 is then driven to reduce the hydrostatic pressure, after which the valve 14 van be opened and the new drill head or liner can be introduced in the bottom part of the borehole 15.

It should be noted that the figures are not drawn to scale. A typical drilling assembly according to the invention can be several hundreds of meters.

C L A I M S

1. Drilling assembly for drilling a borehole into geological formations, which assembly comprises:
- a drilling shaft placable in the borehole, which shaft comprises a drilling head; and
- a pump device placable in the borehole, wherein the pump device comprises sealing means for sealing a first borehole part below the sealing means from a second borehole part above the sealing means, and wherein the pump device is enabled to pump a fluid from the first borehole part to the second borehole part.

2. Drilling assembly of claim 1, further comprising a substantially tube shaped casing placable in the borehole, and wherein the sealing means includes a first sealing for sealing the pump device on the casing inner wall and a second sealing for sealing the pump device on the drilling shaft, such that in longitudinal direction the first borehole part is sealed off from the second borehole part.

3. Drilling assembly according to claim 2, wherein said casing comprises near one end of the casing a valve for closing said one end of the casing.

4. Drilling assembly according to any one of claims 1-3, wherein the drilling shaft extends through the pump device, and the drilling shaft is rotatably arranged relative to the pump device.

5. Drilling assembly according to any of the claims 1-4, wherein the drilling shaft comprises a slick drilling string.

6. Drilling assembly according to any of the claims 1-5, characterized in that the pump device is drivable by a driving fluid or an electric motor.

7. Drilling assembly according to claim 6, wherein an opening is arranged in the casing wall to which the pump device is connectable.

8. Drilling assembly according to claim 7, wherein an annular space is defined between the casing and the borehole in which the casing is placed.

9. Drilling assembly of claim 8, wherein said annular space is defined between the casing and another casing fixedly arranged in the borehole.

10. Drilling assembly of claim 8 or 9, wherein means is provided for feeding a driving fluid through said annular space to the opening in the casing wall in order to drive the pump device.

11. Drilling assembly according to any of the claims 1-10, wherein the pump is retrievable from the borehole.

12. Method of drilling a borehole into geological formations which method comprises the steps:

- arranging a drilling shaft in the borehole, which shaft comprises a drilling head;
- arranging a pump device in the borehole, wherein the pump device comprises sealing means for sealing a first borehole part below the sealing means from a second borehole part above the sealing means;
- operating the pump device so as to pump a fluid from the first borehole part to the second borehole part; and
- driving the drill shaft to deepen the borehole.

13. Method of drilling a borehole into geological formations according to claim 12, further comprising:

- lifting the drilling shaft to a position in which the drill head is located underneath and adjacent the sealing means;
- pumping away at least a part of the fluid present above the sealing means;
- opening the sealing means; and
- removing the drilling shaft from the borehole.

14. Method of drilling a borehole into geological formations according to claim 13 wherein said sealing means is a primary sealing means, the method further comprising:

- arranging a secondary sealing means in the borehole below the drilling head.

15. Method of drilling a borehole into geological formations according to claim 14, further comprising:

- lowering the drilling shaft into the borehole to a position in which the drill head is located between the primary and secondary sealing means;
- closing the primary sealing means;
- pumping fluid from underneath the primary sealing means to above the primary sealing means; and
- opening the secondary sealing means.

Fig.1.

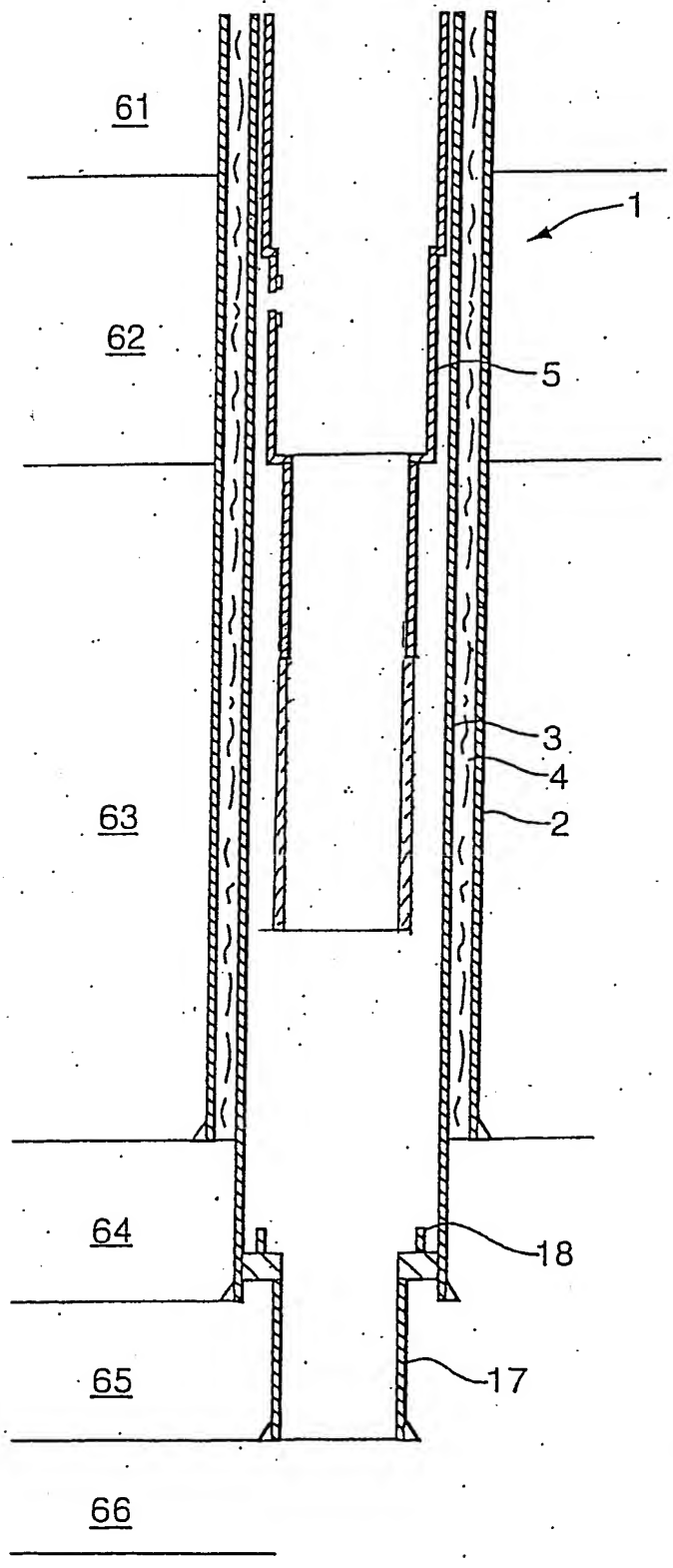

Fig.2.

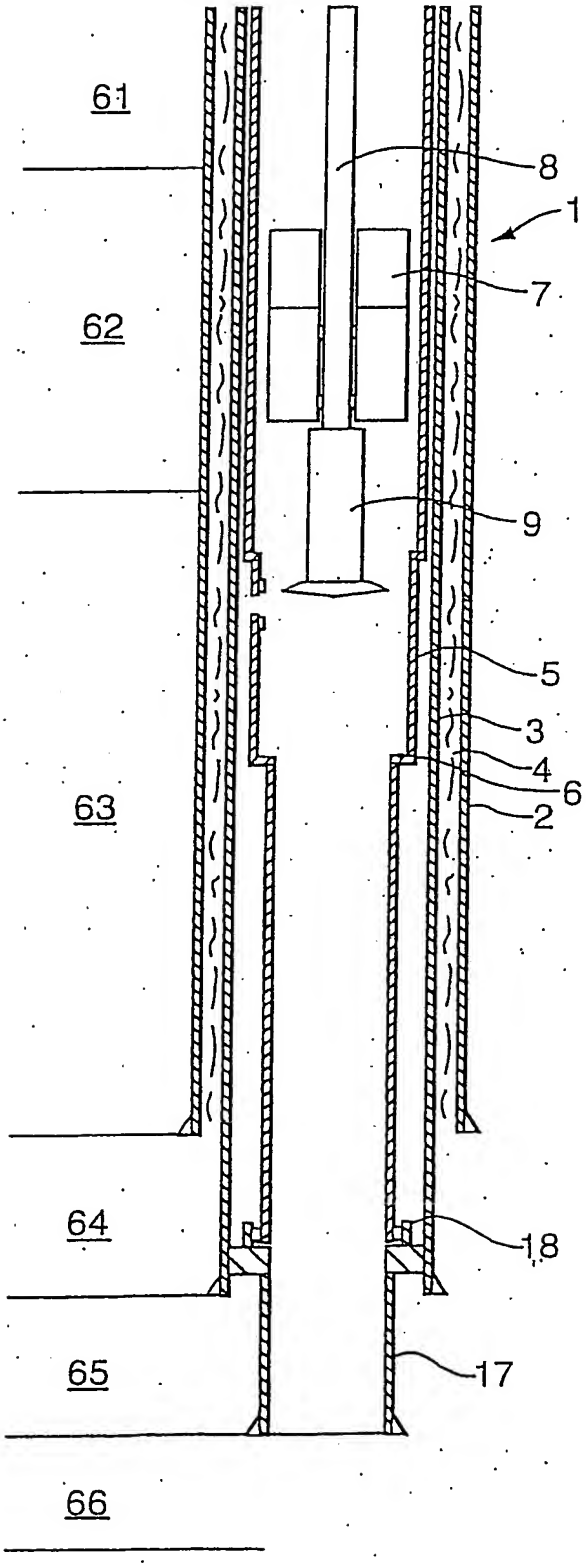

Fig.3.

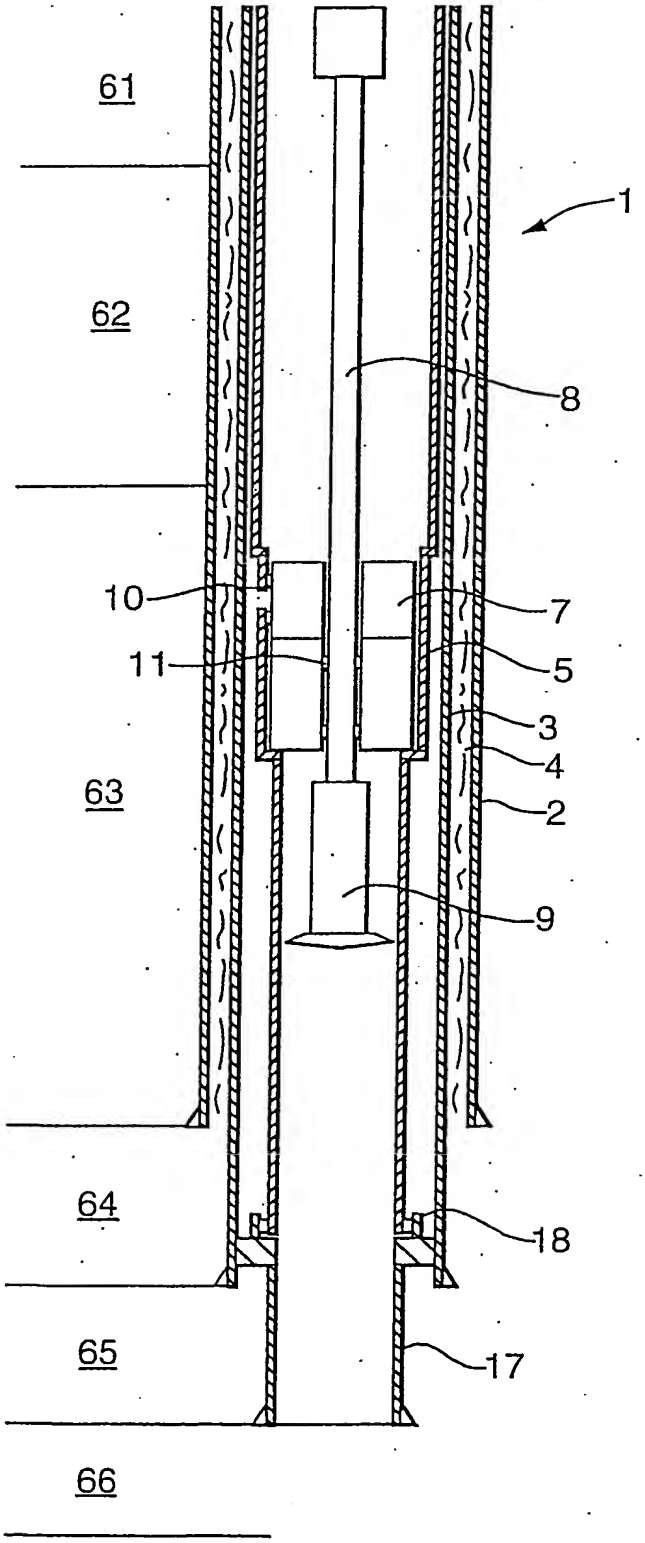
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Fig.4.

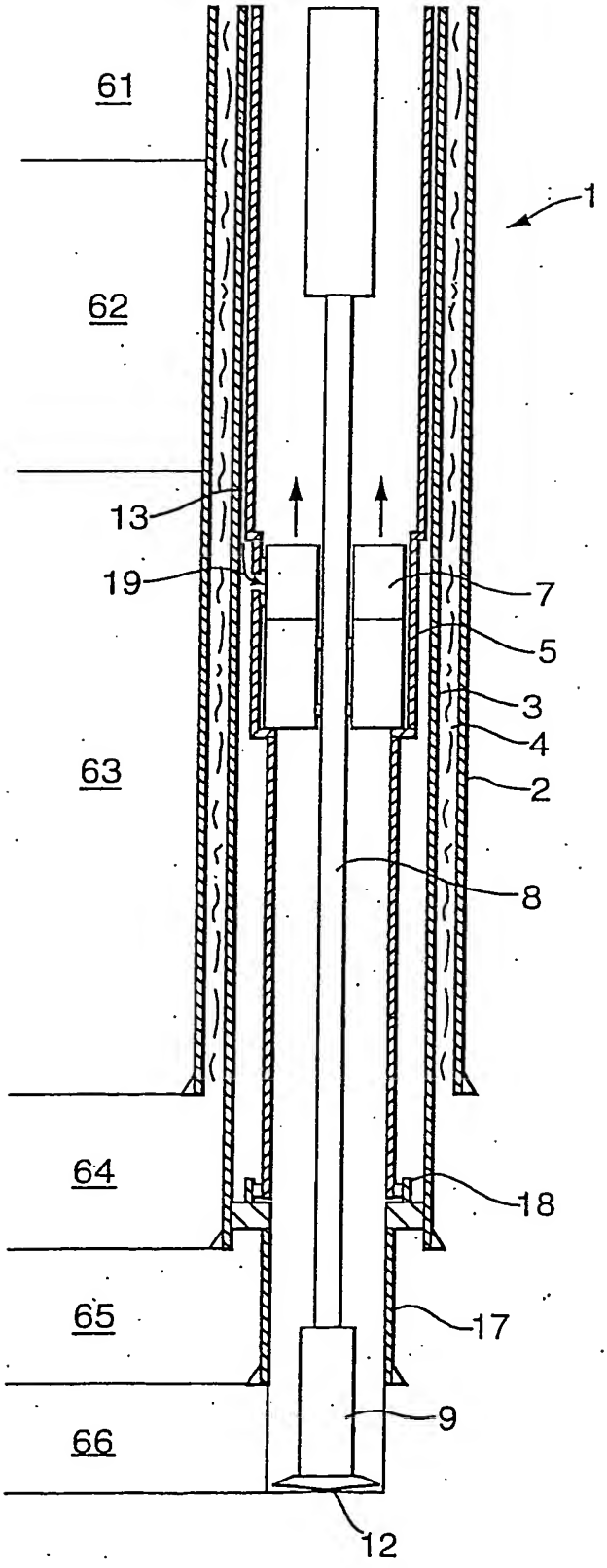
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Fig.5.

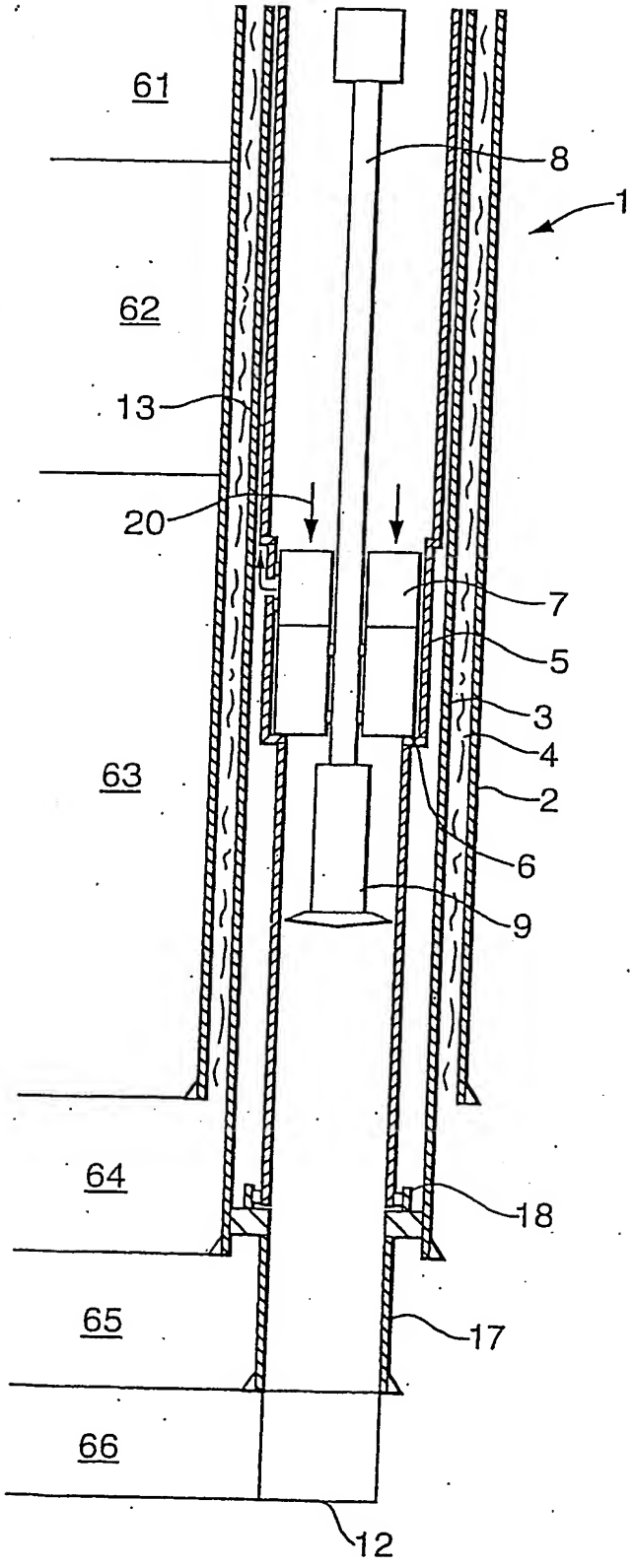
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Fig.6.

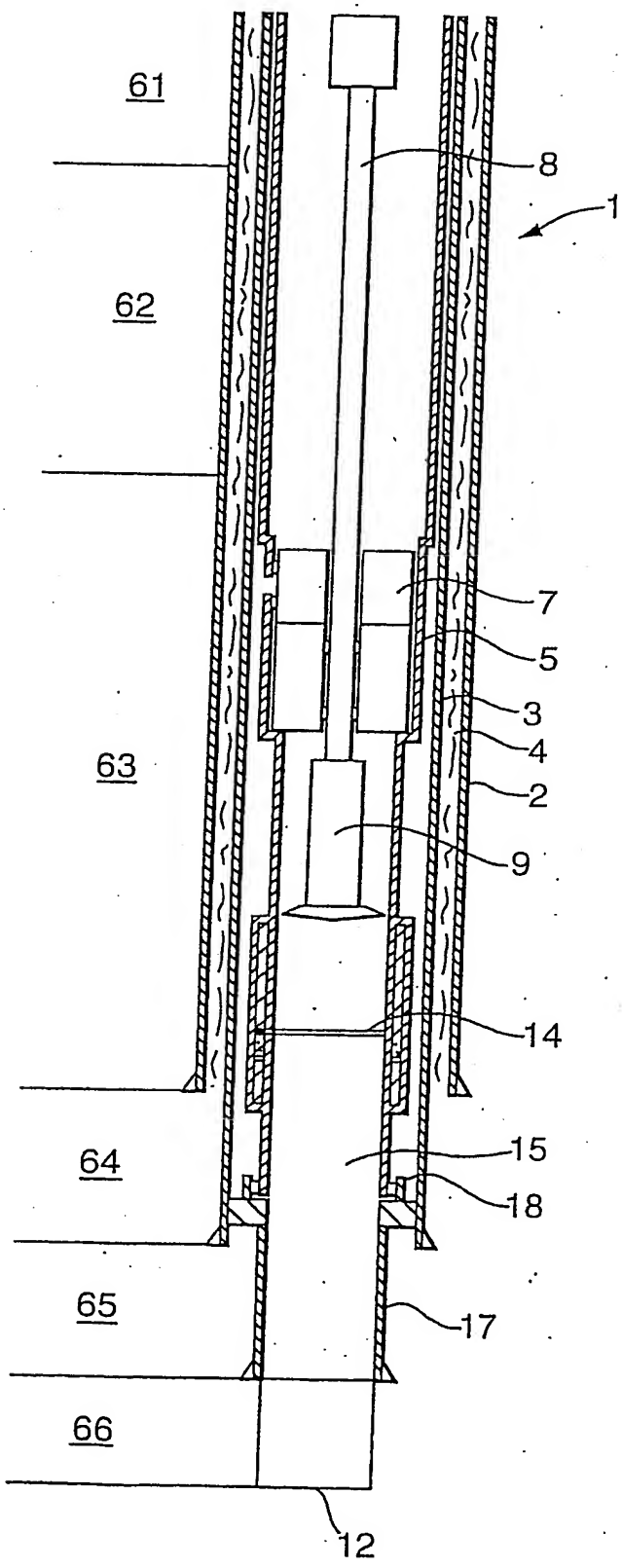
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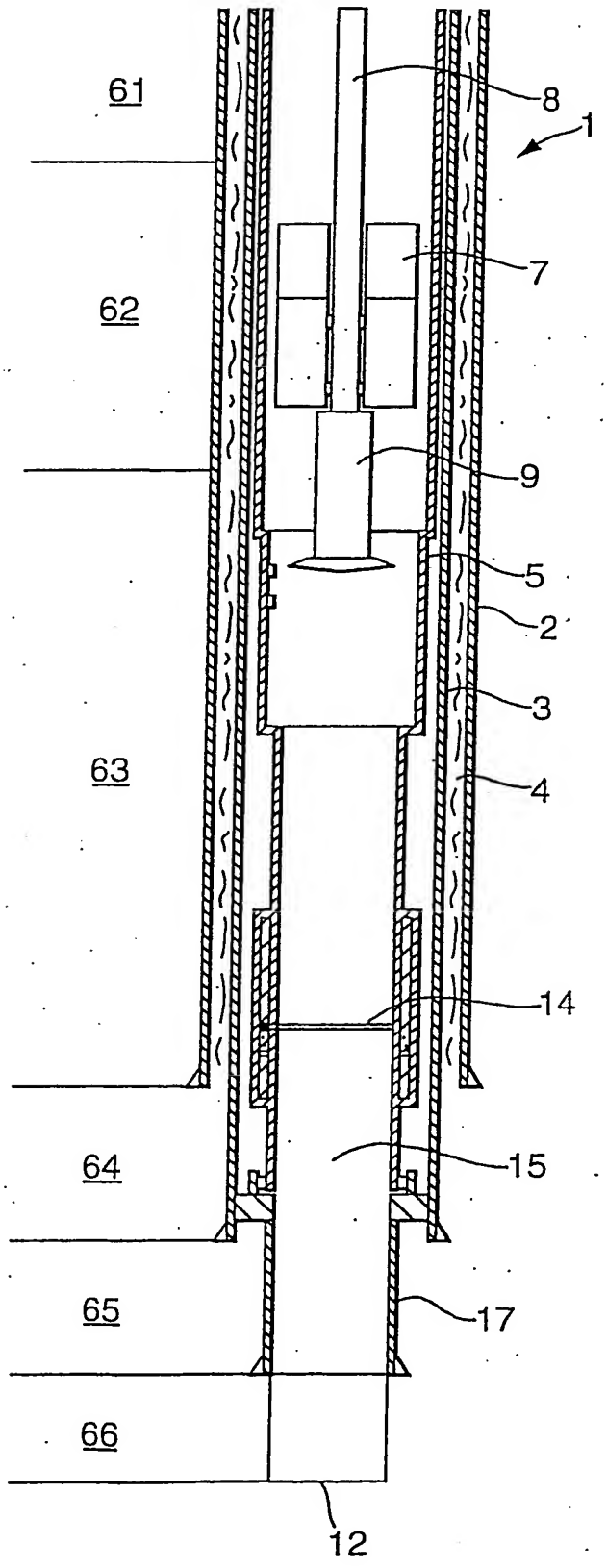
Fig.7.



INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B21/12 E21B21/08 E21B4/00 E21B33/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 744 426 A (REED JOHN A) 17 May 1988 (1988-05-17) column 5, line 30 - line 38 column 5, line 56 -column 6, line 3; figure 1	1,2,4-8, 10-12
P,X	WO 02 14649 A (HASSEN BARRY ;TESCO CORP (CA)) 21 February 2002 (2002-02-21) page 9, line 26 -page 10, line 6 page 12, line 6 - line 8	1,4-6, 11,12
A	US 4 137 975 A (PENNOCK MICHAEL D) 6 February 1979 (1979-02-06) column 2, line 44 -column 3, line 8	1-15
A	US 4 630 691 A (HOOPER DAVID W) 23 December 1986 (1986-12-23) figure 7	1-15

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 November 2002	02/12/2002

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 02/10039

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 898 244 A (SCHNEIDER JOHN L ET AL) 6 February 1990 (1990-02-06) column 3, line 46 - line 55	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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